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Effect of Electrolytic Concentration on Density and Viscosity of Ethanol-Water Mixed Solvent Systems

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Abstract

In the present work the viscosity and density parameters have been determined by taking different concentrations of calcium chloride in different sets of Ethanol-Water mixed solvent systems at 298.5 K. The data so obtained used to calculate the excess viscosity and B-coefficient values. From the viscosity and excess viscosity values the effect of electrolytic concentration have been discussed related to solute-solvent and solvent-solvent interactions.

INTRODUCTION

The viscosity of solution is resistant to flow which is due to internal friction of layers which retards the velocity of other layers. In general, the frictional forces are more at the wall of tube as compare to central part of tube. That's why the central layer flows faster than peripheral layers. In this research paper we have studied the effect of calcium chloride on the density and viscosity of solutions by considering the above concept. The calcium chloride is an inorganic salt which plays an important role in various functions in plant as well as in animal body. One of the important function is maintaining the osmotic pressure across the cell. In addition to that the Ca^{2+} ion is transported through the blood as dissolved ion. The important function of calcium is bone strengthening. In order to perform this function, the transport of calcium to proper place is important which can happen when it get good path for transport.

In our research work we have determined the density and viscosity of ethanol-water mixed solvent system by adding different concentration of calcium chloride. We have taken the 2%,4%,6%,8% and 10 % of calcium chloride (w/v) in 5%,10%,20% and 40 % ethanol (v/v) and then determine the density by weighing and viscosity by flow time method for all the sets of solutions i.e. mixtures.

$$\text{Density} = \frac{\text{Weight of definite volume of pure solvent}}{\text{Weight of same volume of set ofsolvent}}$$

Viscosity

$$n_2 = \frac{t_2}{t_1} \cdot \frac{\varsigma_2}{\varsigma_1} \cdot n_1$$

Where

t_1 = flow time for pure solvent
t_2= flow time for mixture
ς_2= Density of pure solvent
ς_1= Density of mixture
η_1= Viscosity of pure solvent
η_2 = Viscosity of mixture

MATERIALS &METHODS

Refluxed ethanol and doubly distilled water was used for preparation of different sets of ethanol-water mixed solvent systems. Calcium chloride was AR grade from Sigma Aldrich brand. Densities were determined by Pycnometer by the help of single pan balance. Viscosity was determined by Ostwald's Viscometer which was fixed on stand to count flow time for different solvents. For each set three readings have been performed.

RESULTS & DISCUSSIONS

Table No .01 Density of solvent

EtOH ↓ / $CaCl_2$ →	2 %	4%	6%	8%	10%
5 %	1.003	1.004	1.017	1.023	1.031
10 %	1.002	1.003	1.013	1.019	1.027
20 %	1.001	1.002	1.010	1.013	1.020
40 %	0.998	0.999	1.003	1.008	1.015

Table No.02 Viscosity of solvent

EtOH ↓ / $CaCl_2$ →	2 %	4%	6%	8%	10%
5 %	0.01239	0.01474	0.01595	0.01757	0.01919
10 %	0.01417	0.01503	0.01744	0.01860	0.02004
20 %	0.01585	0.01708	0.01996	0.02119	1.02091
40 %	0.02024	0.02170	0.02307	0.02358	0.02446

Table No.03 Excess Viscosity η^E

EtOH ↓ / $CaCl_2$ →	2 %	4%	6%	8%	10%
5 %	-0.93300	-0.93065	-0.92944	-0.92782	-0.91381
10 %	-0.88084	-0.87998	-0.87751	-0.87641	-0.87492
20 %	-0.77793	-0.77766	-0.77377	-0.77254	-0.77207
40 %	-0.56972	-0.56830	-0.56693	-0.56642	-0.56554

The viscosity of 5% ,10%,20% and 40% ethanol-water mixed solvent system have been determined by adding 2 ,4,6,8 and 10 gram of calcium chloride in each set of solvent and the values have been tabulated.
From the table no. 02 the excess viscosities have been determined by using the following formula

$$\eta^E = n_{mix}(x_1 n_1 - x_2 n_2)$$

$n_1 \& n_2$= Viscosities of pure solvent and mixture
$x_1 \& x_2$ = Mole fraction of solvent and mixture
η^E = Excess Viscosity of mixture

The negative values of excess viscosityindicate the attractive forces are predominating in the mixtures which is due to hydrogen bonding of alcohol.

The B coefficients can be calculated for these mixtures by using formula :

$$B = \frac{\eta_{r-1}}{C}$$

CONCLUSION

From the table of viscosity and excess viscosity data we came to conclusion that as the concentration of calcium chloride electrolyte increases from 2%,4%,6%,8% and 10% in 5% ,10% ,20% and 40% ethanol-water mixture the density ,viscosity and excess viscosity values are increasing it is due to solvent-solvent interaction between ethanol and water as well as the solute-solvent interaction between calcium chloride and ethanol-water mixed solvent.

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